# DISTRIBUTION OF COTTON MASS BY LENGTH AND CROSS-SECTION OF PNEUMATIC PIPELINE DURING AIR TRANSPORTATION

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**Abstract:** This article analyzes the productivity of the pneumatic transport system during the transportation of raw cotton from cleaning workshops to cotton ginning plants and proposes ways to prevent excessive air consumption during the process.

**Key words:** pneumatic transport, cotton, air, fan, pipe, separator.

Analysis shows that at cotton ginning enterprises operating in our republic, raw cotton passes through pneumatic transport several times. Depending on the mutual location of the workshops and cotton stacks at the enterprise, the number of pneumatic cotton passages can be up to 4-6.

Depending on the distance of transportation, centrifugal fans of the VS-8M, VS-10M, and VS-12M brands are primarily used in pneumatic units, with a capacity of 30, 55, and 75 kW/h respectively, and an air flow rate of 3.5, 5.5, and 6.4 m3/s. Steel pipes with a thickness of 2-3 mm and an internal diameter of 0.4 m are used as material conductors (air ducts).

In many studies, the pneumatic transport elements of raw cotton, as well as the patterns of movement within the air duct, have been studied at various levels. In these studies, we will pose a slightly different issue - analyzing the process of cotton transportation by air based on engineering calculations based on patterns and indicators identified in current and previous studies.

Material transport productivity is one of the main indicators of pneumatic tires. It is determined as follows:

Π = (1)

where: M- weight of cotton; t-shipping time.

The change in cotton mass along the entire length of the air duct should be determined using the following integral:

(2)

Here is the porosity of the medium (raw cotton), which must be determined using the flow equation. If the initial feed rate of the raw material and the feed rate in an arbitrary section of the air duct are the same, then in the stationary feed mode, the following equality holds:

(3)

Here, and are the porosity and density of the raw cotton at the inlet of the air duct, and are the velocity and density of the raw cotton at an arbitrary cross-section of the air duct, which are determined using the additional equations described above. If the density and velocity of the raw material along the air duct do not change, then the equalities, and hold true, and the volume occupied by the raw material will be as follows:

(4) Due to the volume of the air duct, the proportion of the raw material volume along the air duct (in percent) is equal to [1]. If, at the transfer limit (), the speed of the raw material is equal to its transfer speed and is constant, the raw material occupies part of the volume of the air duct. If the raw material velocity increases by and is taken as , then we obtain the equality . Specifically, if , the raw material occupies a portion of the air duct volume; that is, as the raw material speed increases, the process of its loosening and splitting into individual pieces occurs.Although the obtained equations express general patterns regarding the cotton transportation process by pneumatic transport, they cannot reflect the actual situation in it [2].

The productivity of the transportation process depends on the productivity of the final element in the pneumatic device—the separator (this indicator is also called throughput capacity). Existing separator equipment has the following performance:

- SS-15A separator - 15 t/h.
- SX separator - 22 t/h.

Technological machines, such as the drying drum (model 2 SB-10, SBO) with a capacity of 10 t/h, the UXK and 1XK fine-dust cleaning machines with a capacity of 5-7 t/h, and fiber separators (batteries) with a capacity of 10 t/h. Different productivity of technological machines causes excess cotton to accumulate in front of low-performance machines when they operate at full capacity. This, in turn, is inappropriate due to the excessive occupation of working areas and the emergence of fire hazards. Therefore, we perform calculations based on the average productivity indicator of most machinery - P = 10 - 12 t/h.

If we convert the productivity from t/h to kg/h: P = (10 ÷ 12) t/h = 2.78 ÷ 3.33 kg/h. Transportation time can be determined as follows:

t=

(5) where: vm- material (cotton) speed, m/s; - transport distance (air pipe length), m. From this, after simple transformations, we get:

M =

(6) Here, M is the weight of the cotton corresponding to the length of the air pipe. This equation holds under the following conditions: l > 0; vm> 0.

In our previous studies, we determined the velocities of cotton and air at the beginning of the pipeline. At the initial distance of 1 m, the speed of the cotton is close to the speed of the conveyor belt [2]. The actual speed of the conveyor belt is 3 m/s. At the end of the 1 m distance, the speed of the cotton reaches 4.5 m/s. Assuming the average velocity, vm=3.5 m/s. Then the productivity P=2.78 kg/s, when l =1 m

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When P=3.33 kg/s, l =1 m

1 м According to the obtained figures, during air transportation, only 0.80–0.95 kg of cotton corresponds to the length of the air pipe.

In our previous studies, it was determined that the density of cotton coming out of the rick breaker is around g = 36 kg/m3, and if the cotton mass is M = 0.79 - 0.95 kg, the volume of such a body is equal to:

V= M / g = (0.79 - 0.95) /36 = 0.022-0.026 m3.

The volume of an air duct 1 m long is Vk= 1·π · r2=1·3.14·0.22=0.1256 m3. Let's find their ratio in percentages:

V % = (17.6 – 20.7) % .

Subsequently, the cotton speed increases and the air speed decreases. At a distance of 50 meters, the cotton porosity increases twofold (from 0.4 to 0.8), while its density decreases twofold (g=36/2=18 kg/m3), the cotton speed reaches 9-10 m/s (meaning the average speed is around vm = 6.5 m/s), and the air speed decreases by up to 15 m/s. If we calculate based on these:

Cotton volume V= M / g = (21.38÷25.62) /18 = 1.19 ÷ 1.42 m3. The volume of a 50 m air duct is Vk= 50·0.1256 = 6.28 m3. Let's find their ratio:

V % = (19.0 - 22.6) %

If we analyze the results obtained (Figure 1), it turns out that when transporting cotton by air, if it is assumed that the cotton is transported evenly, the cotton occupies only 18–23% of the pipe volume when spread along the length of the air duct. These calculations show that when transporting cotton by air, the main (large) part of the air duct remains empty.

Of course, this part is occupied by air and has great carrier potential. If we take into account that the calculations of air and material velocities are significantly lower than the calculated values, our opinion about the inefficient use of air transport power becomes even more justified.

At the same air velocity, an increase in the cross-section of the air duct leads to an increase in air flow and, consequently, electrical power, while a decrease leads to a decrease in air flow and power. Based on this, it can be concluded that the actual diameter of the air transport pipeline d=0.4m is significantly higher than the required one.

Such a diameter of the air duct is justified by the fact that it prevents cotton from getting clogged at the beginning of the duct as a result of uneven, large layers, and also facilitates the formation of an aerial mixture in the initial part of the air duct. Accordingly, ensuring the loosening and uniform feed of the cotton ensures that the air duct does not clog even with diameters smaller than the actual ones and that the material moves easily within the air duct [2]. The transition to the use of small-sized air ducts, in turn, allows for a reduction in waste air purification costs, fiber removal from exhaust air, metal consumption, and a further improvement in the operational characteristics of air transport equipment.

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